

भारतीय मानक
प्राकृतिक निर्माण पत्थरों के सामर्थ्य गुणों को
ज्ञात करना — परीक्षण पद्धतियाँ
भाग 1 संपीडन सामर्थ्य
(दूसरा पुनरीक्षण)

Indian Standard
DETERMINATION OF STRENGTH PROPERTIES OF
NATURAL BUILDING STONES — METHODS OF TEST
PART 1 COMPRESSIVE STRENGTH
(*Second Revision*)

ICS 91.100.15

© BIS 2013

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

FOREWORD

This Indian Standard (Part 1) (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Stones Sectional Committee had been approved by the Civil Engineering Division Council.

Building stones are available in large quantity in various parts of the country and to choose and utilize them for their satisfactory performance, it is necessary to know the various strength properties determined according to standard procedure. This standard has, therefore, been formulated to cover the standard method for determining the strength properties of various stones. This standard covering compressive, transverse and shear strength properties was published in 1957 and was subsequently revised in 1974 where property of tensile strength was also added as the same was also important for assessing the suitability of stone; the revision was issued in four parts. Other parts are:

- Part 2 Transverse strength
- Part 3 Tensile strength
- Part 4 Shear strength

This standard has been brought out to incorporate the experience gained based on the use of the standard since its last revision. The major modifications incorporated in this revision are as follows:

- a) SI units have been used,
- b) Size of the samples has been specified as 'stones of adequate size' in place of the requirement of at least 25 kg specified earlier,
- c) Load dimension of specimen has been modified thereby specifying the same to be more than 10 times its largest size of mineral grain present in the stone,
- d) Surface finishing requirement of specimen has been modified by making reference to IS 9179 : 1979 'Method for preparation of rock specimen for laboratory testing',
- e) Vacuum saturation in water has been specified for conditioning of the test specimens in place of normal immersion,
- f) Rate of loading has been modified in line with IS 9143 : 1979 'Method for the determination of unconfined compressive strength of rock materials',
- g) The word 'rift' has been replaced with 'plane of anisotropy', and
- h) The minimum number of test specimen has been revised from three to five for test for each of the set of conditions.

The composition of the technical committee responsible for the formulation of this standard is given in Annex A.

In reporting the results of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'.

*Indian Standard*DETERMINATION OF STRENGTH PROPERTIES OF
NATURAL BUILDING STONES — METHODS OF TEST

PART 1 COMPRESSIVE STRENGTH

*(Second Revision)***1 SCOPE**

This standard (Part 1) lays down the procedure for determination of compressive strength of natural building stones used for constructional purposes.

2 REFERENCES

The standards listed below contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

<i>IS No.</i>	<i>Title</i>
IS 1121 (Part 2): 2012	Methods of test for determination of strength properties of natural building stones: Part 2 Transverse strength (<i>second revision</i>)
IS 9179: 1979	Method for preparation of rock specimen for laboratory testing

3 SELECTION OF SAMPLES

3.1 The sample shall be selected to represent a true average of the type or grade of stone under consideration.

3.2 The sample shall be selected from the quarried stone or taken from the natural rock, as described in **3.2.1** and **3.2.2** and shall be of adequate size to permit the preparation of the requisite number of test specimens.

3.2.1 Stones from Ledges or Quarries

The ledge or quarry face of the stone shall be inspected to determine any variation in different strata. Differences in colour, texture and structure shall be observed. Separate samples of stone of adequate size of the unweathered specimens shall be obtained from all strata that appear to vary in colour, texture and structure. Specimens that have been damaged by blasting, driving wedges, heating, etc, shall not be included in the sample.

3.2.2 Field Stone and Boulders

A detailed inspection of the stone and boulders over the area shall be made where the supply is to be obtained. The different kinds of stones and their conditions at various quarry sites shall be recorded. Separate samples for each class of stone that would be considered for use in construction as indicated by visual inspection shall be selected.

4 TEST SPECIMENS AND CONDITIONING

4.1 Test specimens shall be made from samples selected in accordance with **3** and shall be in the form of cubes or cylinders. They shall be cut or drilled from the samples. The diameter or lateral dimension (distance between opposite vertical faces) of a test specimen shall not be less than 50 mm or 10 times the size of the largest mineral grain present in the rock, whichever is greater and the ratio of height to diameter or lateral dimension shall not be less than 1:1 (*see also 7.2*).

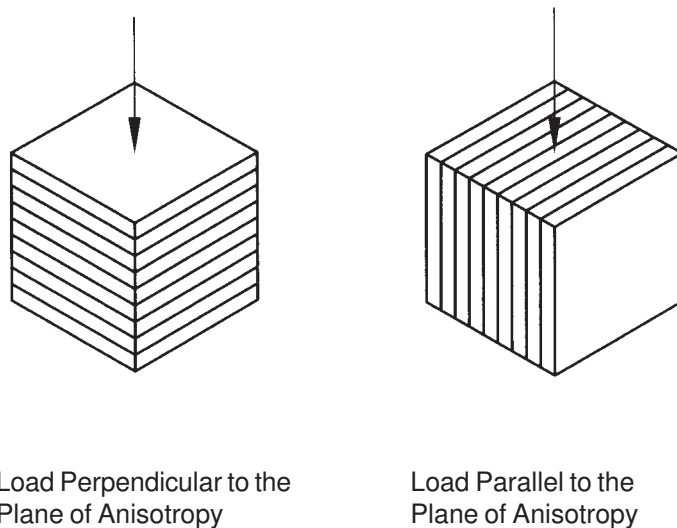
NOTE — Test specimens prepared out of broken beams in the transverse test [*see IS 1121 (Part 2)*] may also be used.

4.2 The load-bearing surfaces shall be prepared in accordance with IS 9179.

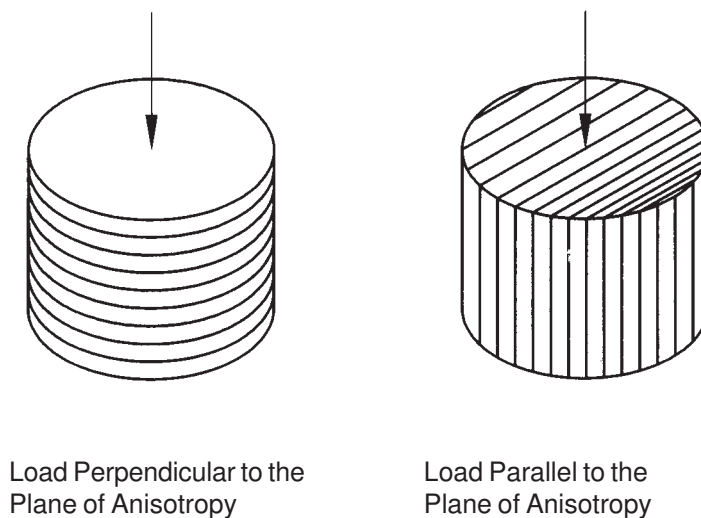
4.3 The load-bearing surfaces and the direction of the plane of anisotropy shall be carefully marked on each test specimen after finishing.

4.4 Five test specimens shall be used for conducting the test in each of the conditions mentioned in **4.4.1** and **4.4.2**. In each of these conditions, separate tests shall be made for the specimen when the load is parallel to the plane of anisotropy and perpendicular to the plane of anisotropy (*see Fig.1*). In all, twenty test specimens shall be used.

4.4.1 The test specimens shall be saturated by vacuum saturation by immersing in water maintained at 20 °C to 30 °C in an evacuation vessel under a vacuum of about 50 mm of Hg to 100 mm of Hg. Specimens shall be initially immersed continuously for about 4 to 5 h in vacuum and then its mass is measured at an interval of 1 h (sample being replaced



1A Cubic Test Specimens



1B Cylindrical Test Specimens

FIG. 1 ANISOTROPIC PLANES IN NATURAL STONES

back in evacuation vessel after weighing) till constant mass. Constant mass is considered to have been achieved when two consecutive hourly measurements of mass do not vary by more than 0.1 percent of the saturated mass. Vacuum may be created by a suitable air suction pump.

4.4.2 The test specimens shall also be tested in dry condition and shall be dried in an oven at $70 \pm 5^\circ\text{C}$ for 48 h and cooled in a desiccator to room

temperature (20°C to 30°C) to constant mass. Constant mass is considered to have been achieved when two consecutive hourly measurements of mass do not vary by more than 0.1 percent.

5 APPARATUS

A testing machine of sufficient capacity for the tests and capable of applying load at the specified rate shall be used. The machine shall be equipped with

two steel bearing plates with hardened faces. One of the plates (preferably the one that normally bears on the upper surface of the test specimens) shall be fitted with a ball seating in the form of a portion of a sphere, the centre of which coincides with the central point of the face of the plate. The other compression plate shall be plain rigid bearing block. The bearing faces of both plates shall be preferably larger than the nominal size of the test specimen to which the load is applied. The bearing surface of the plates when new, shall not depart from a plane by more than 0.012 5 mm at any point. The movable portion of spherically seated compression plate shall be held on the spherical seat, but the design shall be such that it is possible to rotate the bearing face freely and tilt it through small angles in any direction.

6 PROCEDURE

The load shall be applied continuously without shock and increased at a constant stress rate such that failure will take place in about 5 to 15 min of loading. Alternatively, the stress rate shall be within the limits of 0.5 MPa/s to 1.0 MPa/s. The load shall be applied until the resistance of the test specimen to the increasing load breaks down and no greater load is sustained. The maximum load applied to the test specimen shall be recorded and the appearance of the stone and any unusual features in the type of failure shall be noted.

7 EVALUATION AND REPORT OF TEST RESULTS

7.1 The maximum load (in N) supported by the test specimen before failure occurs, divided by the area

of the bearing face of the specimen in mm² shall be taken as the compressive strength of the specimen.

7.2 When the ratio of height to diameter (or lateral dimension) differs from unity by up to 25 percent, the result shall be calculated to that standard test specimen as follows:

$$C_c = \frac{C_p}{0.778 + 0.222 (b/h)}$$

where

C_c = compressive strength of standard test specimen,

C_p = compressive strength of the specimen having a height greater than the diameter or lateral dimension,

b = diameter or lateral dimension, and

h = height.

7.3 The average of the five results in each condition separately (*see 4.4*) shall be taken for purposes of reporting the compressive strength of the sample provided the individual variation is not more than ± 15 percent of the average. Otherwise repeat tests shall be made.

7.4 The compressive strength shall be expressed in N/mm².

7.5 Identification of the sample, date when sample was taken and type of stone shall be reported.

7.6 Size and shape of test specimens used in the tests shall be indicated.

ANNEX A (Foreword)

COMMITTEE COMPOSITION

Stones Sectional Committee, CED 6

<i>Organization</i>	<i>Representative(s)</i>
In personal capacity (C-3/3188, Vasant Kunj, New Delhi)	DR A. K. DHAWAN (Chairman)
A.P. Engineering Research Laboratories, Hyderabad	DIRECTOR JOINT DIRECTOR (<i>Alternate</i>)
Associated Stones Industries (Kotah) Limited, Mumbai	SHRI S. C. AGARWAL
Builders Association of India, Mumbai	SHRI LAL CHAND RALHAN SHRI RAM AVTAR (<i>Alternate</i>)
Building Materials and Technology Promotion Council, New Delhi	DR SHAILESH KUMAR AGRAWAL SHRI J. K. PRASAD (<i>Alternate</i>)
Central Building Research Institute (CSIR), Roorkee	DR (SHRIMATI) RAJNI LAKHANI DR ACHAL KUMAR MITTAL (<i>Alternate</i>)
Central Public Works Department, New Delhi	CHIEF ARCHITECT (NDR) SENIOR ARCHITECT- IV (<i>Alternate</i>)

IS 1121 (Part 1) : 2013

<i>Organization</i>	<i>Representative(s)</i>
Central Road Research Institute (CSIR), New Delhi	HEAD (PAVEMENT EVALUATION DIVISION) SHRI K. SITARAMANANJEYULU (<i>Alternate</i>)
Central Soil and Materials Research Station, New Delhi	SHRI MURARI RATNAM SHRI HASAN ABDULLAH (<i>Alternate</i>)
Centre for Development of Stones, Jaipur	SHRI KULVEER SINGH
Directorate General Border Roads, New Delhi	SHRI B. S. PANDEY
Directorate of Geology & Mining, Lucknow	REPRESENTATIVE
Directorate of Mines and Geology, Udaipur	SHRI O. P. JAIN SHRI N. S. BOHRA (<i>Alternate</i>)
Gem Granites, Chennai	SHRI SHIV SHANKAR SHRI RAJIV BAHADUR (<i>Alternate</i>)
Geological Survey of India, Kolkata	SHRI G. S. MURTHY DR G. M. RAO (<i>Alternate</i>)
Gujarat Engineering Research Institute, Vadodara	SHRI L. V. ASHARA SHRI S. H. MAKWANA (<i>Alternate</i>)
Indian Bureau of Mines, Nagpur	REPRESENTATIVE
Indian Institute of Technology, Chennai	DR MANU SANTHANAM PROF M. S. MATHEWS (<i>Alternate</i>)
Military Engineer Services, Engineer-in-Chief's's Branch, Army Headquarter, New Delhi	MS MALA MOHAN SHRI JAGDEV THAKUR (<i>Alternate</i>)
National Council for Cement and Building Materials, Ballabgarh	DR V. P. CHATTERJEE SHRI N. K. SHARMA (<i>Alternate</i>)
Public Works Department, Government of National Capital Territory of Delhi, Delhi	CHIEF ENGINEER (BPZ B-1) SHRI AJAY GUPTA (<i>Alternate</i>)
Public Works Department, Government of Rajasthan, Jaipur	SHRI CHIRANJI LAL SHRI G. C. PANWR (<i>Alternate</i>)
Public Works Department, Government of Tamil Nadu, Chennai	SUPERINTENDING ENGINEER EXECUTIVE ENGINEER (GENERAL) (<i>Alternate</i>)
School of Planning and Architecture, New Delhi	PROF S. K. KHANNA SHRI SHUVOJIT SARKAR (<i>Alternate</i>)
Shriram Institute of Industrial Research, Delhi	DR LAXMI RAWAT SHRI R. K. SINGH (<i>Alternate</i>)
Stone Technology Centre, Jaipur	SHRI K. VIKRAM SHRI VIKRANT V. RASTOGI (<i>Alternate</i>)
Stone Technology Foundation, Jaipur	SHRI JAYESH V. RASTOGI
Svil Mines Ltd, Floriana Group, New Delhi	SHRI SANJAY JAIN SHRI MANMOHAN GARG (<i>Alternate</i>)
Tamilnadu Minerals Limited, Chennai	SHRI K. SUMANTH BABU SHRI S. VISWANATHAN (<i>Alternate</i>)
The Indian Institute of Architects, Mumbai	SHRI DIVYA KUSH SHRI AJAY PURI (<i>Alternate</i>)
BIS Directorate General	SHRI A. K. SAINI, Scientist 'G' & Head (Civ Engg) [Representing Director General (<i>Ex-officio</i>)]

Member Secretaries

SHRI SANJAY PANT
Scientist 'E' & Director (Civ Engg), BIS
SHRI S. ARUN KUMAR
Scientist 'C' (Civ Engg), BIS

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act*, 1986 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Copyright

BIS has the copyright of all its publications. No part of these publications may be reproduced in any form without the prior permission in writing of BIS. This does not preclude the free use, in course of implementing the standard, of necessary details, such as symbols and sizes, type or grade designations. Enquiries relating to copyright be addressed to the Director (Publications), BIS.

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards: Monthly Additions'.

This Indian Standard has been developed from Doc No.: CED 6 (7718).

Amendments Issued Since Publication

Amendment No.	Date of Issue	Text Affected

BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002

Telephones: 2323 0131, 2323 3375, 2323 9402

Website: www.bis.org.in

Regional Offices:

Telephones

Central	: Manak Bhavan, 9 Bahadur Shah Zafar Marg NEW DELHI 110002	{ 2323 7617 2323 3841
Eastern	: 1/14, C.I.T. Scheme VII M, V.I.P. Road, Kankurgachi KOLKATA 700054	{ 2337 8499, 2337 8561 2337 8626, 2337 9120
Northern	: SCO 335-336, Sector 34-A, CHANDIGARH 160022	{ 260 3843 260 9285
Southern	: C.I.T. Campus, IV Cross Road, CHENNAI 600113	{ 2254 1216, 2254 1442 2254 2519, 2254 2315
Western	: Manakalaya, E9 MIDC, Marol, Andheri (East) MUMBAI 400093	{ 2832 9295, 2832 7858 2832 7891, 2832 7892

Branches : AHMEDABAD. BANGALORE. BHOPAL. BHUBANESHWAR. COIMBATORE. DEHRADUN. FARIDABAD. GHAZIABAD. GUWAHATI. HYDERABAD. JAIPUR. KANPUR. LUCKNOW. NAGPUR. PARWANOO. PATNA. PUNE. RAJKOT. THIRUVANATHAPURAM. VISAKHAPATNAM.